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Supreme Court of the United States

October Term, 1930.

No. 630.

DEFOREST RADIO COMPANY,
Petitioner,

vs.

GENERAL ELECTRIC COMPANY,
Respondent.

REPLY BRIEF FOR PETITIONER.

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REPLY BRIEF FOR PETITIONER.

Respondent's brief makes out its case of patentable invention for Langmuir by studiously suppressing the essential similarity in principle of operation between the modern vacuum tube and the earlier tubes of Fleming and DeForest, and by asserting, on the other hand, an untrue difference in principle of operation based upon matters of terminology or upon unsworn statements from patents, publications or advertising circulars—an asserted difference, moreover, which is positively denied by witnesses in this case, including Respondent's own expert, Hogan.

Note.—In this brief we refer to the copy of the opinions rendered heretofore which Respondent filed with its brief, using its same notation "Op. p.—."

Italics in quotations are ours, unless otherwise stated.

Respondent's Statement of the Case Is Misleading.

The attempt to suppress the essential similarity in principle between DeForest's original three-electrode tube and the tubes now claimed to infringe starts with Respondent's statement of the case. Without being able to criticize Petitioner's statement of the case, it has rewritten the statement of scientific principles involved, *to omit any reference to the all-important "space charge" effect.* On pages 8 and 9, which deal with the scentific principles applicable to both the new and old tubes (top of page 7), Respondent says that the variations in current in the output circuit of a three-electrode tube are due to "variations in the effective *potential of the plate*" (p. 8), where it should state that the variation in the output current is due to more or less *neutralization of the space charge effect,* explained in our brief, page 9; and it says further as to the effect of ionization,

> "The physical phenomenon is rather complicated but it is sufficient for the purposes of this case to know that when ionization is present in a tube, the gas acts as a sort of conductor increasing the current to a value beyond what it would be at the same voltage in the absence of ionization."

The effect of ionization is no more complicated than the rest of the things Respondent was here explaining. This is merely a convenient way of avoiding reference to space charge, which is the controlling characteristic in the operation of both the old and the new vacuum tubes. It is not

true, as Respondent here states, that "the gas acts as a sort of conductor." In both DeForest's tube and the modern tube the current consists entirely of electrons. The gas is no more a conductor for the current in earlier DeForest tubes than it is in the highest vacuum tubes made today (in which there is always some gas). What Respondent should have said at this point is that when ionization occurs, the positive charges of the ions begin to neutralize the space charge caused by the crowd of negative electrons around the filament and that, because of this neutralization, more of them are free to pass across the tube to the plate; and that if the neutralization continues to increase, due to increased ionization, the space charge will entirely disappear.

The importance of this point in the case arises from the fact (noted on p. 10 of our brief) that *the characteristic operation of* all *three-electrode tubes*, and especially when used as amplifiers, *depends upon a varying neutralization of the space charge* in the tube *by the varying potential imposed upon the grid electrode.* This is the celebrated "grid effect" which made the three-electrode tube so important and useful in modern industries. It is the thing which enables the three-electrode tube to reproduce in its output circuit a perfect copy, in enlarged form, of any current variations imposed upon its input circuit. *If the gas content of the tube, and so the ionization, is great enough to destroy or to seriously impair the space charge, then the three-electrode tube ceases to function according to its characteristic principle of operation.*

It is this principle of operation which was fundamental and characteristic with the earlier DeForest tubes, just as

it is the characteristic which makes the modern tube operative and valuable. *If the earlier DeForest tube had enough gas in it so that in operation the space charge was neutralized, it could not have operated in its* characteristic *and intended manner.* The amount of power which an early DeForest tube could have handled without destruction of the essential space charge depended upon the degree of the evacuation, it is true, but this is just as true of the tubes made in accordance with the patent in suit, which clearly states in its own specification that the degree of evacuation is to be proportioned to the voltage which it is intended to apply in use, that is, the power it is intended to handle (Rec., Vol. VI, p. 779).

The *characteristic* principle of operation of both the earlier DeForest tube and the modern tube is, therefore, *the control of an electron flow by the combined effect of grid and space charge.* This is the important and essential similarity which Respondent would conceal in its method of stating the principles involved.

The Asserted Dependence of DeForest and Fleming upon Gas.

Having thus omitted to state the essential characteristic of operation in three-electrode tubes,—both DeForest's early tube and the modern tube,—Respondent then proceeds to assert that the characteristic principle of DeForest's tube was due to gas effects, while the tube of the patent relies upon a pure electron flow.

In support of this, Respondent cites four instances where Fleming refers, in published papers, to "gaseous conduction" or the "conductivity of ionized gas" (p. 24).

These do not even tend to prove the point. They are instances of the use of a standard terminology to which we refer on page 45 of our main brief, and they are statements by one who, as there pointed out, insisted on the elimination of every possible remnant of gas. It cites next two statements of DeForest which are nothing but guesses made by DeForest at the early date of 1906 as to the theory of operation of his audion tubes. Neither DeForest nor anyone else in the world understood the underlying principles of these tubes at that time. It next refers to a DeForest application containing references to the ionized gas in audion tubes, which is on a par with the statements of Fleming already referred to. It next refers to a statement by Gernsback which it dignifies as part of a "critical study" of the audion. Gernsback had no standing in the art and most evidently knew little or nothing about the subject. He was merely accepting current terminology for vacuum tube operation. Next, Respondent refers to an advertising circular of the DeForest Company which seems to us is entirely disposed of by our observations on page 54 of our main brief. Next, it refers to a von Lieben *et al.* patent which it says covers a device "seriously considered by the Telephone Company for telephone relay uses". Its adoption was *not* seriously considered and there is no evidence that it was. It was merely exhibited by the inventors on their own motion. *It* was *indeed* a device depending upon a gas content, and quite different in this respect from the DeForest audion. Observations as to its operation have no more relevancy to the DeForest tube than observations as to the operation of a Hewitt mercury vapor lamp would have, (to which Respondent also refers further along).

Next, Respondent cites Whitney's mistaken understanding that some gas was necessary in order that electrons might be emitted from the filament. The record shows clearly that both Whitney and Langmuir were not abreast of the scientific knowledge on this and related facts. Others, such as Millikan, Richardson, Arnold, Wehnelt, J. J. Thomson, H. A. Wilson, and Lilienfeld, knew well that gas was not essential to the discharge. Next, Respondent cites the Arnold application in which it is merely stated that it had "been commonly *supposed*" that ionization was necessary for a vacuum tube to "operate efficiently". Next come two quotations from Langmuir's testimony, one asserting that Fleming and DeForest depended upon gas ionization, and the other asserting that the gas ionization in these devices, due to the fact that they were "poorly exhausted", modified and partly eliminated the space charge and otherwise interfered with their operation. Next, Respondent again quotes the Arnold patent application as in turn quoting the DeForest patents to the effect that gas ionization was involved in his tubes, and quoting the Fleming patent as indicating the same.

The character of this evidence is not impressive for the establishment of the scientific fact essential to Respondent's argument. Even standing alone, we think it would be far from sufficient for its purpose. *The fact is, however, that it is directly contradicted by Respondent's own expert Hogan, who testified in this case in open court.* His testimony, to which we have referred in our main brief (p. 51), was not, as suggested by Respondent (on p. 35), quoted from some other case without authority of the witness himself. This testimony was read to Hogan while

he was on the witness stand and he fully confirmed and adopted it in this case as his testimony (Rec., Vol. I, pp. 113, 117, 118, 120), and it is, as we have already pointed out, to the effect that the early DeForest audion with which Hogan was very familiar did *not* operate upon any different principle from the high vacuum tubes then in use by the Telephone Company which, as Respondent itself asserts (brief, p. 35), are tubes within the scope of the patent in suit. *This is the direct and positive testimony of Respondent's own expert given in this case when he was subject to examination by both parties,* and must certainly far outweigh the desultory and fragmentary comments which we have reviewed above.

As to the Fleming valve, the testimony of Waterman is equally positive. Waterman was not called as a witness in this case but his testimony in the *Marconi* suit was stipulated into this case as substantive evidence (Rec., Vol. III, p. 1485), and when given was subject to cross examination by an adverse interest. We reviewed it on pages 49 and 50 of our main brief.

We confidently assert that the court cannot find on the evidence in this case that the early DeForest tubes were operable only because of ionization which occurred in them and that the modern tubes asserted to infringe operate upon an entirely different principle; but on the contrary must find that the *principle of operation of both the early DeForest tube and the modern tube is control of an electron stream by the combined effect of the grid and space charge.*

Indeed, a most conclusive proof that ionized gas was not the "conductor" of the current in the early Fleming and DeForest tubes is the fact that *when the gas is removed*—

when the highest vacuum that Langmuir advocates is obtained—*the current is still conducted across the tube.* Moreover, it was usual to use tubes below ionization voltages from the earliest days of the Fleming and DeForest tubes. If those tubes operated, as they did, when there was practically *no* gas ionization, how can it be seriously believed, as Respondent contends, that ionized gas constituted the "conductor" upon which the operation of the tubes depended. Quite obviously the fact is, as the *evidence* shows, the tubes have always depended upon electron flow, and have been useful solely because of that fact.

In this connection we must point out how unwarranted is the comparison (on p. 35 of Respondent's brief) of the testimony of Millikan in the *Hewitt* suit with the testimony of Hogan, above referred to. In the first place, the testimony of Millikan in the *Hewitt* suit was not made evidence in this suit, and second, the testimony referred to contrasted the *Hewitt mercury vapor lamp device* with the high vacuum tubes of the Telephone Company. The Hewitt mercury lamp device, as every one knows, operated by reason of a heavy mercury vapor boiling out of a pool of mercury and filling the tube during operation, and had nothing in common with the three-electrode tube either of DeForest or of the Telephone Company.

Amplifying Tubes.

Langmuir testified in this case that when ionization was sufficient to materially affect the operation, an *amplifier* tube was most sensitive at about 27 volts and that amplification practically disappeared in the neighborhood of 40 volts. Respondent objects (p. 55) to our reference to this testi-

mony to indicate that DeForest's tubes, as used by him, and as demonstrated to the Western Electric Company in 1912, with voltages ranging from 35 to 60 and over, could not have been affected materially by gas ionization. It says this is unfair because Langmuir testified as to "a particular tube" and that the conclusions cannot be generalized. But Langmuir's testimony was not concerned with the action of one tube. *He was endeavoring to show a general principle*, namely that the presence of gas increased the amplifying action but *very strictly limited the range of voltage usable* if amplification was to be attained (Rec., Vol. 2, p. 1261) and he put in the testimony "to illustrate" the point. Nor did he depend upon one tube but refers to tests upon a number (Rec., Vol. 2, pp. 1264-66). In one case the maximum amplification was at 27 volts while with 30 volts the tube, he says, "is a very poor amplifier, poorer than if it had a good vacuum" (Rec., Vol. 2, p. 1264, bottom). Another tube which he refers to as a "third tube" showed a maximum amplifying power at 24 or 25 volts which fell "to practically nothing at 30 volts" (Rec., Vol. 2, p. 1266).

DeForest demonstrated his amplifier tube to the Western Electric Company at a voltage of approximately 40 (Interf. Rec., Vol. II, line 6, p. 2166) and he was using amplifier tubes in the Federal Telegraph Company's service with voltages considerably greater than 50 volts.

This testimony also shows therefore that the characteristic operation of the DeForest amplifiers was not the characteristic operation of an amplifier depending upon gas ionization. It is the testimony of Respondent's own witness,—the alleged inventor—and cannot be overcome by speculative references to supposed theories of operation

found in publications or papers dating back to the time when people did not understand the underlying principles of the audion.

This testimony as to amplifier action is peculiarly important because it is essential to Respondent's present argument to show that the *amplifier* tubes of DeForest *depended upon* gas ionization. As to the detectors, everyone agrees that an ionization effect was, in general, desirable. Langmuir himself testified:

> "I think everybody recognizes that in detector tubes gas greatly increases the sensitiveness as a detector in those parts of the curve where the curvature is made abnormally large by the presence of gas" (Rec., Vol. 2, p. 1264).

Respondent Now in Effect Withdraws Its Eleventh Hour Definition of the Invention Used to Obtain the Rehearing in the Court of Appeals.

As we point out in our main brief (p. 41), where Respondent stated to the court below that Langmuir's invention consisted of taking out a gaseous conductor upon which DeForest and Fleming depended, its argument required that it assert this as a scientific fact and not as a mere mistaken supposition by early commentators because in the latter case it would be crediting Langmuir merely with furnishing an explanation of an existing thing and not with producing a new thing.

In its brief before this Court (p. 22) Respondent practically withdraws its eleventh hour definition which served it so well at the rehearing. This is not surprising because it is evident that it will not stand up in the face of the testimony of Langmuir himself to which we have referred in our main brief (p. 46). In withdrawing from this untenable position, however, Respondent attempts to do it so adroitly as not to lose any benefit it may have gained from its erroneous statement. It asserts now that its eleventh hour definition was not a new definition at all but was the same one which it had used throughout the litigation. This is obviously not so as appears from a mere comparison with the definitions quoted by Respondent at pages 19 to 21. The point of the earlier definitions is that the operation is by electron flow substantially unaffected by ionization, which brings the asserted difference between the old and the new tubes back to a difference in degree of ionization involved or of vacuum attained.

If Respondent were willing now to stand by its statement that the eleventh hour definition means merely the same thing as the earlier definitions just referred to, we would have no objection. But while saying this at one place it still refers continuously elsewhere in the brief to the "gas conductors", etc. of the earlier tubes. Apparently the purpose is to withdraw from its untenable position when it is directly attacked, while attempting to obtain the benefit of the asserted but unreal difference by mentioning it elsewhere as if it were real and admitted.

The Arnold-Langmuir Priority Issue.

Misrepresentations of the Opinions of the Lower Tribunals.

Respondent states at page 18 that, "The question of priority was decided by the Patent Office Tribunals in favor of Langmuir". This statement is repeated at page 38. It is not correct. The ultimate authority of the Patent Office, the Commissioner of Patents, decided priority wholly against Langmuir, and wrote a full opinion explaining precisely how he reached his decision (Op., pp. 83 to 90). We believe this Court will find his opinion to be better considered and more convincing than either opinion of the two tribunals of the Patent Office below him.

Another error is the statement at page 60 (also at p. 76), that the District of Columbia Court of Appeals was "following" the Board and thereby held that Langmuir conceived in August, 1912 and reduced to practice in November, 1912. On the contrary the Court of Appeals *attempted equally* to follow the two lower tribunals of the Patent Office (Op., p. 95, line 9) one of which assigned the dates above mentioned, and the other of which assigned April 15, 1913 for Langmuir's first date of invention (Op., p. 47, line 3).

Disputed Questions of Fact.

Respondent asserts (p. 84) "that this case turns on inferences or conclusions to be derived from substantially undisputed facts, and not upon findings of fact based on conflicting testimony", and that this Court's ruling in

Adamson v. *Gilliland* has no application to the case. This is not correct.

Langmuir testified that certain phenomena observed in his laboratory in August, 1912 indicated the presence of the invention. Respondent presents this testimony at length in its brief at pages 62 to 66. Petitioner's witness Becker testified that the phenomena must have occurred without the presence of the invention (Rec., Vol. 3, pp. 1791 *et seq.*). Respondent mentions Becker's testimony at the top of page 74 and context and goes on to say that "Langmuir's testimony in rebuttal (Vol. III, pp. 1916 to 1923) completely disposes of Becker's suggestion * * *." Here Langmuir tried to contradict Becker on the scientific facts. These facts were in dispute. A reading of the testimony of the witnesses shows Becker's superior knowledge and accuracy of statement, but this can scarcely put one in the position of Judge Morris who heard and saw these witnesses and decided in favor of Arnold.

Arnold testified, with corroboration by Jewett and Colpitts, that he fully disclosed the plan of the invention to them on November 1, 1912. In reply, Respondent quotes (p. 77) Langmuir's testimony *given not in court but in prepared affidavits for the earlier interference proceeding.* In these, Langmuir attempted to contradict Arnold. The Trial Court accepted the testimony of Arnold and his corroborating witnesses (Op., p. 122 and context).

It is interesting to notice that Respondent's references to the record for Arnold's testimony in its argument against him are almost all to the Interference Record, which it cites as "I. R." In fact its references are to Langmuir's attempted contradictions of Arnold. But Judge

Morris heard Arnold and saw him on these matters, and of course heard and saw Langmuir but did not permit him to testify as an advocate (Rec., Vol. 2, pp. 1117 to 1119, 1137, 1159, 1160, 1167, 1168, 1209, 1210, 1240, 1241) as he had done in his prepared affidavits. Judge Morris was the only tribunal that saw and heard these witnesses.

Respondent asserts (pp. 78 to 80) with urgent emphasis that Arnold did not know how to get the necessary vacuum for the invention, and that thus he lacked the "idea of means". This is simply to invite disbelief of the testimony of Dr. Millikan that he himself had instructed Arnold fully in an adequate "idea of means" (Rec., Vol. 1, pp. 442, Q9, to 449, Q22; also pp. 457, Q38, to 459, Q43). The District Court heard and saw Dr. Millikan. It had to appraise Millikan's testimony, to which Respondent's argument is in opposition.

Respondent says (p. 81, top) Arnold did not appreciate his audion 7-A. Arnold says he did appreciate it (Rec., Vol. 2, p. 759, Q743). It was for Judge Morris to weigh his testimony, which Respondent now disputes.

Obviously, therefore, the doctrine of the case of *Adamson* v. *Gilliland* is applicable, and is conclusive to the present case.

The Insinuation that the Telephone Company Appropriated the Invention from Langmuir.

This insinuation appears at pages 59, 80 and 83 of Respondent's brief.

Although both Langmuir and Arnold testified in regard to the occasion of the paper that Langmuir "orally summarized" Arnold never admitted that the invention was

disclosed in any way, and Langmuir made no specific nor direct assertion to that effect. Against Respondent's insinuation that the Telephone Company learned first of the invention on this occasion, there are the following considerations:

(a) There is the explicit affirmative testimony of Arnold and his witnesses that Arnold made and disclosed the invention about a year earlier, and that in the meantime he and his associates pursued the activities naturally consequent on such disclosure as narrated in our main brief.

(b) The only written record of Langmuir's talk is an "abstract" prepared and published by him, which makes no disclosure of the invention whatever (Rec., Vol. 6, pp. 1361-2, Deft's. Ex. 326). Of all the many persons who heard Langmuir, none was called as a witness.

(c) Three days before the talk, Langmuir made oath to the application for the patent here in suit with disclosure and claims diametrically opposed to the fundamental condition that Respondent now insists is most essential for realizing the invention. It ought not to be supposed that Langmuir had reversed himself in those three days (Rec., Vol. 6, p. 659 *et seq.*, Deft's. Ex. 62; see especially the mention of "bombardment without heating", etc., pp. 665, 667, 668; the date of the oath is on p. 674; see claims numbered 1, 3 and 5 on pp. 672, 673).

(d) About five months before this Langmuir talk, the General Electric Company had filed a patent application claiming the invention here in issue for its employee Coolidge instead of its employee Langmuir, and in the said

Langmuir application executed three days before the talk, Langmuir explicitly identified the Coolidge application and acknowledged Coolidge's priority. It ought not to be supposed that in his talk Langmuir disclosed what he then regarded as Coolidge's invention (Rec., Vol. 6, p. 664, Deft's. Ex. 62, p. 941 *et seq.*, Deft's Ex. 67; Respondent admitted in its main brief below, p. 241, that the original Langmuir specification acknowledged Coolidge's priority).

On page 80 of Respondent's brief it is stated "Arnold never succeeded in making any good tubes until after Langmuir's Physical Review paper was published." This statement is contradicted by the evidence as to tubes made by Arnold and to which we have referred on pages 72 to 77 of our main brief. Arnold had tubes in commercial operation in the Telephone Company's plant for a month or two prior to the publishing of the paper referred to.

Arnold's Conception Was Complete.

Respondent's attack on Arnold's invention (pp. 78 to 83) consists chiefly in the assertion that "Arnold had no adequate idea of means." The context shows that what Respondent means by this is that Arnold did not have an adequate idea of means for *manufacturing* his tubes, especially for getting a good enough vacuum.

There are two answers to this: first, it is not true, and second, if true, it would not mean that Arnold had not a completed conception. We have pointed out (Main Brief, p. 85) that Dr. Millikan very positively testified that he had, years before, taught Arnold all of the requirements for high evacuation which are taught by the patent in suit.

And he testified further that the means he had thus taught Arnold would be perfectly adequate to turn a DeForest tube into a tube which would stand 100 or 200 or more volts and give "regular reproducible operation" free from "harmful ionization". We think it is ridiculous, therefore, to say that Arnold had no knowledge of the mechanism for producing high vacua.

But in using this argument Respondent shows a lack of familiarity with the law applicable to the situation. The patent law requires, for a complete conception of an invention, that it include a *definite idea of means for accomplishing the intended result.* This is apparent from the quotation from Robinson (p. 23, *infra*) stating the nature of the inventive act, and is amply supported by authority. This rule of law does *not*, however, mean that the inventor of a device,—having conceived a useful object to be attained and also a useful mechanism for attaining that object, must also conceive methods or apparatus for manufacturing that device. Methods of manufacture or machines for manufacturing may be inventions in themselves but they are inventions quite apart from the device which it is intended to manufacture. Arnold's conception was of a device *for amplifying speech currents.* He conceived the purpose to be attained and he conceived means for attaining it, namely a DeForest audion in which the vacuum was improved to the point where gas did not affect the operation at the required voltages. That is a complete conception of the alleged invention here in question, including a "complete and adequate idea of means" *for amplifying voice currents.* We have shown (Main Brief, pp. 21 to 25) that all of the *means for getting a vacuum* which are taught by the

patent in suit are also taught by prior patents and publications, and as already noted, Arnold himself knew of these things. But manifestly, these methods of manufacture are no part of the alleged invention here in controversy.

On November 1, 1912, Arnold proposed to get his high vacuum by the use of a mercury pump, to which he had been accustomed, supplemented by liquid air and charcoal to exclude mercury vapor. He soon learned that liquid air was difficult to obtain at that time, and he changed his plan and decided to use a Gaede molecular pump. In the last sentence of the first full paragraph on page 79, it is insinuated that there was something reprehensible in this change of plan. However, this Gaede molecular pump to which Arnold changed his plan, and which he procured and put in operation as soon as possible, is precisely the means recommended by Langmuir in his patent and at many other places, for getting the requisite vacuum.

At the middle of page 79 Respondent says that nowhere in the records until October, 1913, "did Arnold make any reference to this *new* idea of means". This statement is not correct. Defendant's Exhibit 248 (former 11) is a copy of the order for the new Gaede molecular pump, dated January 23rd and 24th, 1913. Defendant's Exhibit 250 (former 13), dated April 23, 1913, notes the arrival of the "new molecular pump", and Defendant's Exhibit 255 (former 18), page 105, with date April 25, 1913, notes "audion 20.2 re-evacuated with Gaede molecular pump" and goes on with a record of its successful tests thereafter for which the data were mentioned at the top of page 74 of our main brief. There is another explicit and favorable record of

use of the same "molecular pump" at pages 114, 115 of this same exhibit.

Instead of facing the facts, respondent tries (last paragraph on p. 79) to convict the Telephone Company of inconsistency in applying for a patent on a specific use of the evacuation process that Arnold had learned from Dr. Millikan. This application was a mistake in its first claims as explained in the testimony of Folk (Vol. 3, pp. 1858-1862) and Arnold (Vol. 2, p. 785). When the mistake was apprehended the corresponding claims were cancelled. Respondent did not hesitate to put Coolidge on the stand to testify that certain claims made by him were a mistake (Rec., Vol. 3, pp. 1524-1526).

Misrepresentations of Arnold's Disclosure of November 1, 1912.

On pages 76 and 77 Respondent seeks to make it appear that Arnold was interested in improving the DeForest audion only far enough to get rid of "blue haze". This seems to us a rather ridiculous attempt. What Arnold admittedly proposed to Jewett and Colpitts was to improve the vacuum in the DeForest audion so that it would stand sufficient voltage to serve as a practical telephone amplifier. Blue haze was sometimes (though not frequently) referred to as an indication that gas effects were present when they put too much voltage on DeForest's tube, but it obviously was referred to as a symptom and not as the disease which it was intended to cure. The witnesses testified repeatedly without mention of blue haze as a criterion. Arnold said:

> "I explained to Mr. Colpitts that the *erratic behavior* of these audions was no doubt due to the re-

> sidual gas in them. I had become very familiar with the effects of gas * * * I knew there would be a great gain in steadiness of behavior if *all gas* could be eliminated * * *" (Interf. Rec., pp. 2166, 2167).

Jewett testified that Arnold's proposed improvement was

> "a tube like these DeForest audions but with greater electron emission and so much better evacuated that *erratic behavior* due to positive ionization would be eliminated * * *" (Interf. Rec., p. 2219).

and Colpitts testified:

> "This view of the proper audion operation *as being substantially unaffected by positive ionization* was held all along by Dr. Arnold and myself after our discussion on November 1, 1912" (Interf. Rec., p. 2228).

For Arnold and Langmuir alike, blue glow is a test *sometimes* used. Langmuir's witness, Dushman, relied on it almost exclusively (Interf. Rec., p. 2136, line 3 and line 5 from bottom, p. 2137, line 10 from bottom and p. 2138, line 9). The whole testimony on the subject shows that Arnold placed his main and overwhelming reliance on the third electrode test (Interf. Rec., pp. 2181 *et seq.*), which is fully endorsed by Dr. Millikan (Rec., Vol I, p. 454, Q31). For example, on November 29, 1912, Arnold made an elaborate experiment recorded in Defendant's Exhibit 244 (former 7), pages 32 to 35, that was fundamentally based on this approved test and thereby he demonstrated he had a pure electron discharge up to 80 volts on that occasion.

Pumping Audions in December, 1912, and January, 1913.

The re-pumping of DeForest audions in December, 1912, as described in Respondent's brief in the first complete paragraph on page 80, is a misrepresentation in two respects: (1) It was not an effort to realize Arnold's invention, but merely to discover whether the audions that came from the hand of DeForest had as good a vacuum as could be secured by an unaided mercury pump. (2) Arnold's testimony quoted in the third complete paragraph on page 80 of Respondent's brief, refers to an *entirely different matter.* This refers to some audions that Arnold had directed Trimble to make in order to acquire the necessary technique with filament cathodes As to these, the testimony is very complete (Interf. Rec., pp. 2190 to 2192, 2246, 2247; Rec., Vol. 2, pp. 661 to 664), and shows that after some failures, Trimble learned how to manage the filaments and made some audions that were very good, except they were not sufficiently evacuated. When the new molecular pump that had been ordered from Germany arrived, it was used to re-evacuate these same Trimble audions and they were proved by test to be high vacuum audions (our Main Brief, p. 73).

Arnold's Philadelphia Audions.

Selecting part of the testimony instead of the whole, Respondent (p. 82, bottom) finds "30 to 50 volts" mentioned in remote connection with the audions used at Philadelphia in the latter part of 1913. These figures appear not in "written instructions for the use of these tubes",

as Respondent asserts, but in an elementary presentation of their theory of operation (Deft's. Ex. 260, former 23). They relate to a certain one-way amplifier which was never used at Philadelphia, all the amplifiers for that use being rigged up in two-way repeater systems. What the whole testimony shows, instead of a selected part, is that Dr. Kelly actually produced two tubes that were used at Philadelphia, and that he tested them by methods approved by Dr. Millikan; he found they had extremely high vacua and would go to voltages as high as 100 volts. Instead of a limit of 0.005 watts as Respondent tries to imply at the middle of page 83, though it does not assert it exactly, Kelly tested these tubes to values 8 and 11 times as high as 0.005 watts (Rec., Vol. 2, p. 812, Q6 *et seq.*, and p. 830, Q42 *et seq.*).

Respondent scorns "30 to 50 volts" when it is the voltage of an Arnold tube, but often points with pride to voltages within the same range for Langmuir tubes. In the interference proceedings, with the utmost ostentation, Langmuir produced a tube which he made in 1914 and demonstrated it as an exemplification of his invention. He went to 50 volts only, pointing out that this was the limit for that tube (Interf. Rec., pp. 1483 to 1488, 1591 to 1595, particularly paragraph 10 on pp. 1594 and 1595). Of the many tubes made by his company during the war, and which he asserts were examples of his invention, over one-half were type G pliotrons (Interf. Rec., p. 1178, compare p. 528). For these, Langmuir himself stated, "The normal operating anode voltages range from 18 to 44 volts" (Interf. Rec., p. 1181).

Langmuir's Admitted Lack of Perception in Relation to His Tube of August, 1912.

On page 66 Respondent describes the deficiency in Langmuir's August work with his tube as a failure to "understand the theory of its action" and the same idea is advanced on pages 70 and 71. *This was not the trouble with Langmuir's August work.* His trouble was he had not *made* any invention, at all.

An invention in the sense of the patent law, as Robinson on Patents points out, involves "(1) the idea of an end to be accomplished; (2) the idea of a means by which that end can be attained."* In his August work, Langmuir was attempting to discover some principles of natural law (the rate at which gas in a tube "cleaned up" under the action of the "Edison current"). From his own admissions it is clear that he had no idea either of a practical purpose to be accomplished in the useful arts, nor of any means for accomplishing such a purpose. This will be perfectly manifest from the testimony on the point which is referred to in our main brief, pages 83 and 88.

We quite agree with Respondent that it is not necessary for an inventor to understand the scientific theory of his invention, but that is quite a different thing from having no idea at all either of a useful purpose to be accomplished or of a mechanism for accomplishing it. Langmuir had before him a physical tube by which he was attempting to formulate some physical laws, but the evidence is clear that it did not even occur to him then that he had a pure electron discharge (as a matter of fact he did *not* have one),

* Robinson on Patents; Vol. I, § 87.

and it is not even claimed that he thought of any useful purpose the tube would serve.

Exactly here is where the attempted analogy to the "feed-back" case referred to by petitioner on page 73, falls down. In the "feed-back" case DeForest had a physical thing which he was using to produce a commercially useful product, viz., alternating current, and he was doing it by a device never before used for that purpose. Having thus accomplished a useful end by a new device, it was, of course, not necessary that DeForest understand his theory of operation. Respondent states that "there was not a word of evidence in that case that DeForest then appreciated any utility for the thing". This is not true. The testimony of DeForest, Van Etten and Logwood in that case was that they all appreciated the utility of the device. The law, of course, does not require an inventor to appreciate the full, or even the greatest utility, of his invention. But it does require him to have in mind the accomplishment of some purpose useful in the arts. In this connection Respondent seems to entirely misapprehend the effect of the cases cited in our brief (pp. 81-83) and discussed by it on page 71. *The point of these cases is that we cannot find invention except as it arises in the mind of an inventor* (or discoverer). The fact that a physical thing may exist either in nature or through human agency is of no benefit to mankind and of no consequence in establishing the existence of an invention *until it is perceived by somebody to have a useful application* and until the method of applying it to the accomplishment of the useful purpose is recognized. As Judge Learned Hand aptly puts it in *DeLaski v. Tire Co.*, 232 Fed. 884-888:

"Yet invention necessarily involves a conscious element. It is the imaginative projection of an integral ideal of certain selected natural objects. The fortuitous juxtaposition of the elements without any conscious recognition of some pragmatic relation is sterile and valueless."

The attempt on page 72 to meet this difficulty by asserting that Langmuir's August tube *could* have been used as a rectifier fails, first because it is not shown that either Langmuir or anybody else realized that it was useful as a rectifier, and second, because if we *assume* it was useful as a rectifier, there still is no evidence that it was any different sort of a rectifier from that already employed and patented by Fleming. To make it an invention in the rectifier art by Langmuir it would have to appear that it was a rectifier different from Fleming's *and that Langmuir recognized that it was.* There is no testimony that either of these things was true.

The statement on page 74 that Langmuir did rectify alternating current with such a tube in November, is quite misleading. Langmuir says plainly that he applied alternating current to his November tube merely to see what effect it would have upon the electron emission of the filament, and to get a voltage higher than was available with his direct current source (Rec., Vol. 2, p. 1165), not for the purpose of rectifying alternating currents or to see whether that tube rectified any differently from the Fleming tube. He still was interested merely in discovering scientific laws and not at all in producing a new and useful device.

Moreover, Becker's analysis of Langmuir's data established that the alleged rectifier was indeed a gassy tube. Langmuir pronounced a like tube to be a gassy tube when it had an exponent as great as 1.71 for its current-voltage relation (Pltf's. Ex. 21, p. 407), and yet this tube had an exponent of 1.73 (Pltf's. Ex. 100, "Plots", 7th sheet, "R. S. 1353-5"). By so much more was this a gassy tube. On different occasions with different voltages it gave currents that were greater with less voltage (exactly contrary to the behavior of a high vacuum tube), and indeed we find in the contemporary record the entry "rise in pr. [pressure] due to heating of anode". (Pltf's. Ex. 100, pp. S. 1353 and context). Of course "pressure" means *gas*.

Petitioner's witness, Becker, made a tube substantially like Sweetser's tube of August, 1912, and duplicated the experiments which Respondent describes at length on pp. 63 to 66 of its brief. That Becker's tube was substantially a duplicate of Sweetser's tube was admitted by the Respondent at page 247 of its main brief in the District Court. Becker went on and proved (Rec., Vol. 3, pp. 1801, *et seq.*) that when the phenomena described by Respondent occurred, there was a very substantial quantity of gas in the tube, so much that the current was twice its pure electron discharge value. Becker's tube presents a dilemma for Respondent. Plainly it does not embody the invention, and hence the Sweetser tube of which it is a duplicate could not have embodied the invention. Or, if Respondent should choose to repudiate its admission that the Becker tube is a duplicate, then no one knows how to build a duplicate of the Sweetser tube, and therefore, the alleged invention thereof is lost.

Respondent's statement at the bottom of page 73, that Becker admitted Langmuir had "a new type of discharge" is a perversion of his testimony. A reference to the record will show that Becker was simply describing a succession of events, and when he said "a new type of discharge" he merely meant "new" as compared with what immediately preceded. Indeed a little earlier on the same page Becker stated "the phenomenon was not new". And as to Becker's admission that the current was limited by space charge, he explained that he meant a partial space charge, and Langmuir himself has admitted that such partial space charges were old in the prior art. "Of course, even in gaseous discharges, the current, as has been recognized for the last 20 years, is often limited by space charge, • • •", (Interf. Rec., p. 1475).

The only purported study of the Langmuir-Sweetser August, 1912 work that has ever been recorded by any tribunal with a result favorable to Langmuir, was by the Board of Examiners in Chief in the Patent Office. Subsequently thereto, two very careful studies were made, both with results *un*favorable to Langmuir, one by the Commissioner of Patents (Op., pp. 83 to 85) and the other by Judge Morris in the Delaware District Court (Op., pp. 123 to 124).

Langmuir's Alleged "New Type of Discharge".

At the bottom of page 77, Respondent refers to a "new type of discharge", and on page 5 it says that this "distinguishes" the invention, thereby claiming that Langmuir's invention involves a new type of discharge as contrasted with that found in the DeForest tube even when operating at voltages such as used when it served beauti-

fully to amplify weak speech currents in the demonstration before Jewett, Colpitts and Arnold. We have already pointed out (Main Brief, pp. 26 to 28) that there is no new type of discharge involved in the tube of the patent in suit. The fact that the DeForest audion worked properly to amplify voice currents only when used with voltages approximating 40 does not mean that the discharge was of a different type from that referred to in the patent in suit. On the contrary, the patent in suit definitely says that the *tubes of the patent are exhausted with respect to the particular voltage with which they are to be used* and makes it perfectly clear that, if a tube is made in accordance with the patent to stand a voltage of 50, then 50 volts is the critical value for that tube, and that if used with higher voltages harmful gas effects may be expected to appear, notwithstanding that the tube entirely complies with the requirements of the patent and falls within the claims of the patent (*e. g.*, claim 26).

Langmuir's Work Recorded in His Notebook November 22, 1912.

With reference to this work, Respondent states at page 67, line 9 from bottom, that "Langmuir immediately disclosed these results to his associates", and refers to page 2123 of the Interference Record. We ask the Court to turn to this page and see whether it finds therein any disclosure of the invention. So far is the record on which Respondent relies from such a disclosure, that its conclusion is as follows:

> "A plausible hypothesis to account for some of these effects, is that a small amount of some gas

such as argon, always remains in the lamp" (Interf. Rec., p. 2124).

In other words, what the disclosure amounts to is that Langmuir had gas effects instead of a pure electron discharge.

When pressed on cross examination, Langmuir named five persons with whom he discussed this "important" work (Rec., Vol. 2, pp. 1368, *et seq.*). Aside from Coolidge, whom we have discussed at page 89 of our main brief, not one of these gave any testimony to a disclosure of the invention.

The notebook entry of November 22, 1912 to which Respondent refers on page 67, may state a "theory of Edison current" that was "new" to Langmuir at the time, but every word of it except the part that Langmuir admits to be erroneous, is found more fully and clearly stated in the previously published papers by Lilienfeld and Child.

The attempt to get Richardson's endorsement at the bottom of page 68, is a perversion of testimony. In the words that follow immediately after the quotation from Richardson, "I was naturally very pleased * * *", Richardson goes on and explains that the "current limitation" *was due to electrostatic charges on the tube walls.* Respondent does not like this explanation and therefore cuts off this part of Richardson's testimony, and supplies Counsel's version, "The 'current limitation', of course, was due to space charge". Then counsel turns to Richardson's book which credited Langmuir with the discovery of the space charge effect. But Respondent neglects to mention that Richardson himself pointed out (Interf. Rec., pp. 313, *et seq.*) that this was a mistake, that at the time he wrote

it in his book he was ignorant of the published papers of Lilienfeld and Child, who had discovered and published this effect before Langmuir.

At the top of page 62 and more especially at the middle of page 66, Respondent asserts that "By the accepted theory of the time, in such a high vacuum there should have been no current at all". Thus according to Respondent, it remained for Langmuir to prove that you could have a current in a high vacuum. This whole subject has been carefully considered by petitioner's expert witness, Dr. Robert A. Millikan, formerly of the Ryerson Physical Laboratory of the University of Chicago and now of the California Institute of Technology (Interf. Rec., p. 886 *et seq.*). Dr. Millikan points out that his own opinion and the published opinions of the highest authorities in physics, such as Wehnelt, H. A. Wilson, and Sir J. J. Thompson, were all in favor of the view that electrons would be emitted and would pass freely in a substantially perfect vacuum.

Inasmuch as Arnold always believed in this now accepted theory of electron emission and current flow in a vacuum, he was in far better position to make the present invention than was Langmuir, who had grave doubts on the matter until some time in the year 1913.

Respondent's assertion quoted above rests on only a very few publications by obscure men, and on *alleged hearsay, reported by Langmuir, subject to due objection.* For example, notice the reliance on Wien at the bottom of page 27 of Respondent's brief, and then notice (Rec., Vol. 2, p. 1227 and Vol. 3, p. 1940) that Langmuir's report of this hearsay was refused admission to the record, and that

Respondent now attempts to rely on this excluded testimony without having even assigned its exclusion as error, as required by Rule 11 of the Third Circuit Court of Appeals. Exclusion of this hearsay by the District Court has *never been overruled.*

Langmuir's "Now what I intend to do".

Respondent labors through a full page (p. 75) to prove that its quotation at the bottom of the preceding page "makes it perfectly clear" that when Langmuir wrote on March 21, 1913 "Now what I intend to do * * *" (our brief, p. 91), he meant that he intended to make an audion *with a plate anode.* He did not say so; he did not even mention a plate anode. If he had meant an audion *with a plate anode,* of course he would have said so. He did not even testify to that effect in the District Court, though we had previously asserted the same position that we assert now, namely that his words as quoted on page 91 of our brief mean exactly what they said. Respondent's effort to qualify them by its quotation on page 74 of "What follows" (so Respondent alleges) is considerably weakened by noticing that it omits six lines that come betwgen.

Langmuir and Alexanderson.

The correct version of the alleged disclosure by Langmuir to Alexanderson is not as given on page 69 of Respondent's brief. On the contrary the proposition of "a hot cathode high vacuum electron discharge apparatus of the three electrode type" was made by *Alexanderson to Langmuir, so Langmuir admitted* (Rec., Vol. 3, p. 1425). And Alexanderson made admissions to the same effect (Rec.,

Vol. 3, p. 1465 and context). So far is Alexanderson's testimony from corroborating the alleged disclosure by Langmuir.

White's Audion No. 2.

Respondent says "The evidence is positive that this audion operated by pure electron discharge", referring to Langmuir's involved reasoning in 1926. But the contemporary records in 1913 were far different. White wrote "it was necessary to run filaments for quite a time to get results consistent with previous day's results". Rather a bad showing on reproducibility. White now conjectures that the fault was due to warping of the grid by the heat.

Dushman recorded a complete failure in his effort to make use of this audion No. 2. See his closing entry "no effect" on page 19 of his notebook, Plaintiff's Exhibit 127.

Langmuir wrote at the same time in reference to this work by Dushman:

> "It is apparent to me that negative electricity leaks off the grid too easily. This is due either to the leads from the grid and the plate or filament coming out too close to each other or to *positive ionization in the bulb*. In the next relays we will use great care to avoid both of these effects. It may be that *a little hydrogen may cut down positive ionization* by removing oxygen for oxygen certainly greatly increases positive ionization. *More probably the best results will be obtained by using the highest possibl, vacuum.* For experimental purposes it may be well to immerse the audion or relay in liquid air *to improve the vacuum* and improve the insulation" (Pltf's. Ex. 131, pp. 60, 61).

The Rule of *Morgan* v. *Daniels* Not Applicable.

On page 60 of its brief, Respondent argues that the usual presumption accorded by the rule of *Morgan* v. *Daniels*, 153 U. S. 120, to a decision of the Court of Appeals of the District of Columbia on the fact issue of priority of invention applies by analogy to the case at bar. The basis for this argument is that the Telephone Company has assisted the defendant in the presentation of the defense of prior invention. It needs but a moment's reflection to perceive that the rule of *Morgan* v. *Daniels* has no applicability. It is a modified *res adjudicata* doctrine and is predicated upon the essential prerequisite of *identity of the party* against whom the decision was given in the previous litigation. The DeForest Company, the only defendant in this action, was not a party to the interference proceeding between Arnold and Langmuir. Therefore, there is no identity of parties in this case upon which to hang *Morgan* v. *Daniels*. Surely, the general rule is in no way affected because the defendant has accepted the assistance of a party to the previous litigation.

Moreover, there is important new evidence, taken in the Court below, which would in any event exclude the case from the rule in *Morgan* v. *Daniels*. We direct attention to one or two examples.

It will be remembered that the Court of Appeals of the District of Columbia relied on the opinions of the Examiner of Interferences and the Board of Examiners-in-Chief of the Patent Office. The Board said of Arnold's disclosure of a plan for improvement of the DeForest audion on November 1, 1912,

> "According to the testimony, Arnold at once perceived just where the troubles lay, and then and there disclosed the invention in issue to Colpitts and Jewett" (Interf. Rec., p. 2505).

In support of the foregoing statement, the Board went on and gave the details of the structure of the tube as conceived and disclosed by Arnold; then the Board said,

> "And if it clearly appears that he knew how to produce such a tube we would consider him entitled to November 1, 1912 for conception of the invention in issue. *But we are not satisfied that he had such knowledge* * * *" (Interf. Rec., p. 2506).

Before Judge Morris, abundant *new evidence was adduced that Arnold had such knowledge,* including his own testimony (Rec., Vol. 1, pp. 567 *et seq.*, Qs. 17 to 21, 31 to 34) and the testimony of his teacher, Dr. Millikan (Vol. 1, pp. 442 *et seq.*). Another line of new evidence in the District Court was Becker's testimony which proved that neither in August, 1912 nor in November, 1912 did Langmuir have a pure electron discharge.

CONCLUSION.

Although patent grants were created as an award to inventors "to promote the progress of science and useful arts" as Respondent urges in the conclusion of its brief, they were not created for the primary purpose of building up private fortunes for the owners of patents, as this Court forcefully pointed out in *Motion Picture Patents Co.* v. *Universal Film Co.*, 243 U. S. 502, at page 510. As the Court stated in that case, the *primary* object of the patent laws is to benefit the public or community at large. It is

certainly as important to the public to prevent an unwarranted monopoly in a universally used and indispensable commodity—one on which virtually the entire population of the nation depends for communication, amusement and medical treatment—as it is to enrich the General Electric Company for establishing what it characterizes as a "wonderful" research laboratory, to *rediscover* what scientists had discovered and published to the world years before. The fundamental basis of the award of a patent was and is that an *invention* be made. It was for *invention* that the patent monopoly was to be and is granted to the *inventor*. The invention of Langmuir, for which he originally asked a patent, was the method of gas-freeing metal bodies *without heat*—a scientific absurdity and an admitted impossibility. The patent issued for an entirely different thing—the vacuum tube *per se*. The *application* disclosed and claimed Langmuir's "invention". The *patent* was built up by a patent solicitor by constant and innumerable modifications, cancellations and additions extending over a period of eleven years.

This is not the sort of a patent which "The framers of our Constitution in their great wisdom" intended to be granted.

Respectfully submitted,

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